Florida International University, Department of Earth and Environment

GLY 5475 Spring 2017: Exploration Geophysics

Lec: MWF 11:00-11:50, Room AHC5-357

Dr. Dean Whitman
Office Hours: MW: 1:30-3:30 PM; Tu 10AM - noon after class, or by appointment

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Syllabus (1/6/17)

Description:

Geophysics is the application of physical principles to the study of the Earth's structure and physical properties. Exploration or applied geophysical techniques are used to determine the physical properties of the subsurface from measurements made by instrumentation placed on the surface or in boreholes in the ground. These techniques were first developed as an aid in the exploration for mineral and petroleum deposits but in recent years, they have been increasingly applied to environmental problems such as hydrogeology and site remediation. Applications of geophysical methods include the determination of subsurface stratigraphy and soil properties, characterization of groundwater flow and storage, the identification and tracing of hazardous substances and contaminants in the subsurface, the detection of buried objects and unexploded ordinance, the characterization of soil and bedrock properties for stability, and the exploration of the subsurface for valuable mineral and energy resources. This course will provide an introduction to the basic field and interpretation methods used in exploration and environmental geophysics. Topics include seismic methods, gravity and magnetic (potential fields), electrical and electromagnetic methods, ground penetrating radar (GPR) and borehole methods. The course will include a Saturday field trip (required) to the Montgomery Botanical Research Center in SE Miami Dade County where many of these methods will be demonstrated.

Learning Objectives/Outcomes

Students completing this course will have a strong understanding of the following:

1. The jargon and terminology used in Geophysics
2. The basic physical laws and concepts behind each of the geophysical methods
3. The instrumentation used in each of the geophysical methods
4. The interpretation of geophysical data using analytical and computer modeling methods with an understanding of the uncertainty and non-uniqueness used in those methods.
5. The application of the various Geophysical methods to problems in environmental site and aquifer characterization and the exploration for mineral and energy resources.

Prerequisites: GLY1010 or 3039, MAC 2311, PHY 2048 & 2049 or PHY 2053 & 2054. **Note:** PHY 2049 or PHY 2054 may be taken concurrently with this course

Required Text:

Burger, H. R, A. F. Sheehan, and C. H. Jones *Introduction to Applied Geophysics, Exploring the Shallow Subsurface*, 2005; ISBN 0-393-92637. You should plan on bringing the textbook (and the CD) with you to class.

I strongly suggest that you conduct an overview reading of each of the assigned chapters before coming to class where you carefully read the introduction and scan through the rest of the chapter while examining the figures and their captions and noting any italicized *key words*.

Software:
Geophysical exploration is heavily dependent on computer based modeling of the data. The textbook comes with a CD containing a set of programs for modeling data from some of the methods. These include REFRACT, for modeling simple dipping layer solutions to reversed seismic refraction profiles, REFLECT for simulating and modeling the waveforms of a shot gather, RESIST for modeling vertical electrical sounding data; GRAVMAG for modeling 2-D gravity and magnetic data; and DIFFRACT for simulating common offset GPR data. The programs on the CD will work on both PC, LINEX, and Macintosh computers. The programs on the CD will not work on newer (post 2011) Macs and users (both Mac and PC) should download software patches at http://cires.colorado.edu/people/jones.craig/GSSH/

All tables in the text are found on the CD in the form of *dynamic tables*, Microsoft Excel templates which apply equations used in the text and where the user can modify parameters to see how the calculated results will vary. These Excel spreadsheets also allow you to produce graphs seen in the text. Some of the homework exercises will involve the use of Excel.

Course Organization and Grading:
Course grade will be based on problem sets (35%), a term project (15%), a midterm (20%) and final exam (20%).
The course will consist of a short lecture on concepts and hands-on Geophysics exercises using paper and the computers in AHC5-357. Lectures will not duplicate all the material in the textbook so you must do the assigned reading.

- Attendance is required. Students are expected to arrive on time. I will be taking roll at the beginning of each class.
- Problem sets will consist of exercises that I will hand out which will sometimes include problems at the end of the chapters. Exercises will normally be due at the beginning of class, one week after they are assigned and may involve work outside of class. Exercises should be either typed of neatly printed on an engineering pad. Late exercises will be marked down.
- The midterm will cover material in Ch 1-4 in the textbook (seismic methods) and the final exam will cover material in Ch 5-8 of the book (Gravity, magnetics, electrical and electromagnetic methods). Exams will be closed book, but you will be allowed to bring in a 1 page hand written formula and note sheet.
- There will be a Saturday (all day) field trip to the Montgomery Center in mid-February (date TBA) where we will demonstrate seismic refraction, electrical, electromagnetic and GPR methods. Attendance on this field trip is **REQUIRED**.

Internet Resources
A course webpage will be maintained with **Blackboard**. This page will contain this syllabus, software, data, and lecture notes for the course.

Important University Policies That Apply to This Class
Academic Dishonesty and Misconduct
All students are expected to adhere to a standard of academic conduct, which demonstrates respect for themselves, their fellow students, and the educational mission of Florida International University. Any act that violates the student/instructor trust will not be tolerated.

Acts of cheating, plagiarism, or lying will result in an “F” grade for the class and the possibility of expulsion from FIU.

All students are deemed by the University to understand that if they are found responsible for academic misconduct, they will be subject to the Academic Misconduct procedures and sanctions, as outlined in the *Student Handbook*.

Tentative Schedule

Week	Topic	Reading
1: Jan 9-13	Introduction Seismic Waves	Ch 1, Ch 2
2: Jan 18-20	Seismic wave propagation ***Ex1:*** Seismic Wave Propagation	Ch 2,
3: Jan 23-27	Seismic refraction method	Ch 3
4: Jan 30, Feb 1,3	Seismic refraction method ***Ex 2:*** Seismic Refraction Method	Ch 4
5: Feb 6-10	Seismic reflection method ***Ex 3:*** Seismic Reflection Method	Ch 4
6: Feb 13-17	Multichannel Seismic Surveying ***Ex 4:*** Seismic Reflection Interpretation Field Trip to the Montgomery Center (TBA)	Ch 4
7: Feb 20-24	**Review** **Midterm (Seismic Methods, Chs. 1 - 4)** Electrical Properties of earth materials	Ch 5
8: Feb 27, Mar 1-3	Electrical Resistivity Methods ***Ex 5:*** Resistivity Modeling and Interpretation	Ch 5
9: Mar 6-10	Electromagnetic methods	Ch 8
10: Mar 13-17	**Spring Break**	
11: Mar 20-24	Ground Penetration Radar ***Ex 6:*** GPR interpretation	Ch 8, notes
12: Mar 27-31	Gravity surveying and reduction Regional gravity studies and anomalies ***Ex 7*** Gravity Data Collection and Reduction	Ch 6
13: Apr 3-7	Gravity Anomalies Due to Simple Shapes 2-D Gravity Anomalies ***Ex 8:*** Gravity Modeling	Ch 6
14: Apr 10-14	Earth Magnetism Magnetic Anomalies ***Ex 9:*** Magnetic modeling	Ch 7
15: Apr 17-21	Magnetic surveying **Review and Questions**	TBA
Finals	Final Exam (Ch 5-8), Time TBA	

Applied Geophysics References (in reverse chronological order)

Reynolds, J.M., 2011, An Introduction to Applied and Environmental Geophysics, 2nd Ed. Wiley Blackwell, 696 pp.

Burger, H. R, A. F. Sheehan, and C. H. Jones, 2005, Introduction to Applied Geophysics, Exploring the Shallow Subsurface,.Norton,

Kearey, P., M. Brooks, and I. Hill, 2002, An introduction to geophysical exploration Blackwell Scientific Publications, 3rd E., 259 p.

Mussett, A. E., and M. A. Khan, 2000, Looking into the Earth: An Introduction to Geological Geophysics, Cambriadge Univ. Press

Reynolds, J.M., 1997, An Introduction to Applied and Environmental Geophysics, Wiley, 796 pp.

Parasnis, D.S., 1997, Principles of applied geophysics, 5th ed., Chapman and Hall, 429 p.

Burger, H.R., 1992, Exploration Geophysics of the Shallow Subsurface , Prentice Hall, 489 p.

Telford, W.M., L.P. Geldart, and R.E. Sheriff, 1990, Applied Geophysics, 2nd ed., Cambridge University Press.

Ward, S.H., ed., 1990, Geotechnical and Environmental Geophysics, Society of Exploration Geophysics investigations in Geophysics,

Milsom, J., 1989, Field geophysics , Open University Press, 182 p

Carmichael, R.S., 1989, Practical Handbook of Physical Properties of Rocks and Minerals, CRC Press, 741 pp.

Robinson, E.S., and C. Coruh, 1988, Basic Exploration Geophysics, John Wiley, 562 p.

Dobrin, M.B., and C.H. Savit, 1988, Introduction to Geophysical Prospecting, 4th ed., Mc Graw-Hill, 867 pp.

Hinze, W.J. ed. 1985, The Utility of regional gravity and magnetic anomaly maps , Society of Exploration Geophysicists, 454 p

Sheriff, Robert E., 1984, Encyclopedic dictionary of exploration geophysics 2nd ed., Society of Exploration Geophysicists, 323 p.

Beck, A. E., 1981, Physical principles of exploration methods : an introductory text for geology and geophysics students , John Wiley, 234 p.

Society of Exploration Geophysicists, 1967, Mining geophysics. vols I and II, Society of Exploration Geophysicists

Keller, G.V.and F. C. Frischknecht., 1966, Electrical methods in geophysical prospecting, Pergamon Press, 519 p.